SEFIRA IS A EU FP7 COORDINATION ACTION ON
Socio Economic Implications
For Individual Responses to
Air Pollution policies in EU +27

Modelling Individual Preferences for Environmental Policy Drivers for 7 European countries

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Graphical Abstract

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Document information

Distribution

Dissemination level		Type
PU	*Public*	*X*
PP	*Restricted to the WP4 partners*	
RE	*Restricted to the SEFIRA consortium*	

Status

Description	Type
For information	
Draft version (internal document)	
Final version (internal document)	
Final version (deliverable, approved on May 2016)	*X*

The research on which this report is based, was financially supported by European Union under the 7th Framework Programme; Theme: ENV 2013.6.5-2 Mobilising environmental knowledge for policy and society Grant agreement: 603941 (Project Title: SEFIRA).

To be cited as: *Valeri E., Gatta V., Polidori P., Avataneo L., Maione M., Kazepov Y., Sergi V., Williams M., (2016), Modelling Individual Preferences for Environmental Policy Drivers for 7 European countries, SEFIRA Project, Working Package 4, Deliverable 4.4, available at: http://www.sefira-project.eu/ad/deliverabless/.*

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1. Introduction

The recent environment and climate emergences as major issues facing society have had profound implications for the decisions made by citizens, industry, government and non-government organizations. Citizens are now demanding 'environmentally friendly' consumption products and services with environmental attributes and the public and private sector are seeking to supply products that meet these needs (Bennett and Blamey 2001).

The evaluation of the use of behavioural modelling and related techniques to evaluate environmental and air quality policies is timely. Policies based on technical measures and technological solutions have been used successfully for many decades, but there is increasing evidence that such measures will not be enough to reduce air pollution concentrations to acceptable levels. One reason for this is that adverse effects on human health can occur even at concentrations which meet existing legal targets. Policies based on *ex-ante* behavioural modelling are therefore likely to play an increasingly important role in the future air quality management in Europe. Such policies will inevitably involve behavioural changes, purchasing decisions, and lifestyle changes. Assessing the impacts of these policies and in particular their acceptability and acceptance will require systematic study and the use of proven techniques.

Choice modelling has been used to generate estimates of non-market environmental benefits around the world (see for instance, Bennett and Blamey 2001, Hoyos, 2010, Hoyos, Mariel and Hess, 2013).

In this context, within the on-going FP7 SEFIRA project a pilot study has been designed and implemented in seven European countries to analyse individual preferences for environmental and air quality policy drivers using discrete choice models (DCMs). In doing so, the stated choice experiment was aimed at:

- selecting five environmental policy drivers (attributes),
- identifying individuals' preferences for the selected policy drivers, and
- highlighting individuals' heterogeneity in eliciting environmental policy preferences[1] and in the elasticity and willingness-to-pay[2] (WTP) measures.

2. Stated Choice Experiment Method

In order to analyse public preferences for environmental policy, a stated choice experiment method has been applied. The method involves a survey in which respondents being presented with a number of choice tasks consisting of two or more choice alternatives (environmental policies) from which he/she chooses the preferred one. Each alternative is described by various levels of a set of attributes (policy drivers), which are influenced by the chosen management strategy. For the theoretical background of the DCMs and evolution over time of the choice modelling as well as the phases implied in setting up a discrete choice survey with a non-technical language, please refer to Valeri et al. (2014).

The most popular model is the *multinomial logit*, which is derived from the assumption that the error terms of the utility functions are independent and identically Gumbel distributed (Ben-Akiva and Lerman 1985). Multinomial logit (MNL) model is characterized by important advantages (e.g. simplicity in

[1] In line with the previous deliverables of the Working Package 4 '*Pilot Study: Discrete Choice Analysis*', due to the interdisciplinary composition of the SEFIRA consortium, also the present work is written with a no-technical style.

[2] For an in-depth investigation of a robust estimation of WTP measures in a choice modeling framework, please refer to Gatta et al. (2015).

estimation, model's closed-form specification, accessible and easy to use packaged estimation software) and relevant drawbacks mainly linked to the assumption of preference homogeneity across respondents (McFadden, 1974) where the estimated parameters represent the marginal utility of each attribute variation. However, it is the first model to be estimated before going toward more flexible and complex DCMs. Although some taste heterogeneity may still be explained in a deterministic manner (Green et al., 2006), more flexible models should be used in order to test for preference heterogeneity via the systematic component of utility and relying on the assumption of either continuous or discrete mixture structure (i.e. mixed logit and latent class model), and integrating latent constructs into the decision making process. The scope of the present report is to demonstrate with a simplified modelling approach that individuals of different countries and with socio-economic backgrounds may differently elicit preferences toward potential environmental and air quality policies. Considering the time constrains of the projects and using a random utility maximisation framework, seven country-specific *binary logit* models, including respondents' stated *non-attendance* strategies have been estimated and discussed in section 4.2.

The linear utility function of respondents U_{ij} with a fixed (non-random) coefficient is:

$$U_i = V_i + \varepsilon_i$$

$$U_i = \sum_k \beta_k X_{ik} + \varepsilon_i$$

$$\varepsilon_i \sim G(0, \mu)$$

where V_i is the deterministic part of the utility while ε_i is the random one; X_{ik} is an explanatory variable (e.g. cost of the measure) for the alternative i; β_k is the estimated parameter for the explanatory variable X_{ik}.

The choice probability in a MNL model is defined as:

$$P_{in} = \frac{e^{V_{in}}}{\sum_{j \in C_n} e^{V_{jn}}}; \quad j = 1, \ldots, i, \ldots, J \quad i \neq j$$

where $0 \leq P_{in} \leq 1, \text{ for all } i \in C_n$ and the sum of choice probabilities of all the alternatives, $\sum_{i \in C_n} P_{in} = 1$, is equal to 1.

In *words*, the previous equation states that the probability of an individual n choosing alternative i out of the set of J alternatives is equal to the ratio of the (exponential of the) observed utility index for alternative i to the sum of the exponentials of the observed utility indices for all J alternatives, including the $i-th$ alternative (Hensher, Rose, Green, 2005, p. 86). V_i is defined above.

The direct elasticity $E_{X_{ik}}^{P_i}$ is the elasticity of the probability P_i of an individual choosing the alternative i with respect to a change in some independent variable X_{ik} as follows:

$$E_{X_{ik}}^{P_i} = \frac{\partial P_i}{\partial X_{ik}} \cdot \frac{X_{ik}}{P_i} = (1 - P_i) X_{ik} \beta_k$$

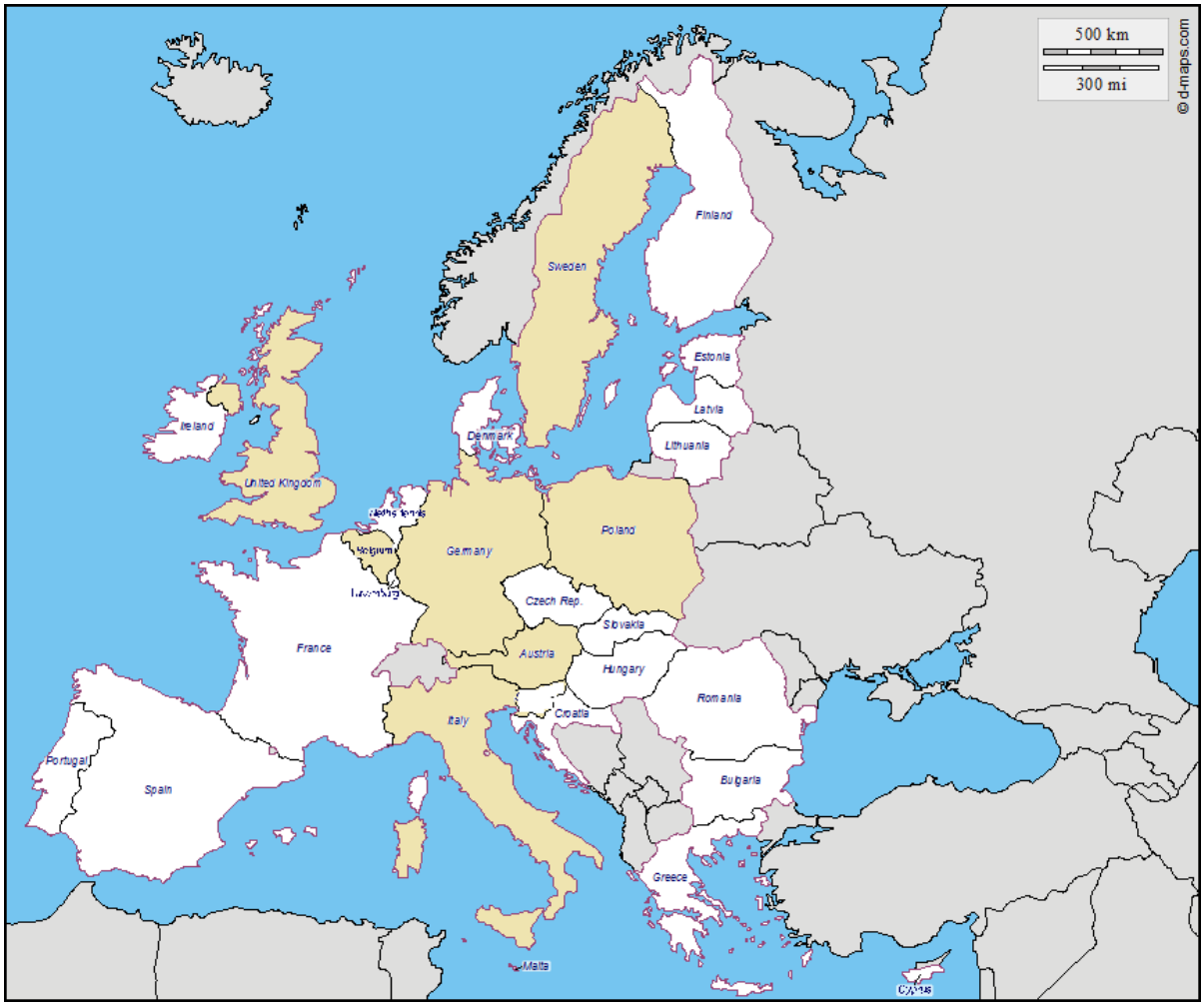
In other words, the elasticity measures the individual's sensitivity to policy driver changes so an high value of the elasticity it may be translated with an high individuals' sensitivity to changes in a specific policy drivers.

3. *Pilot survey description*

3.1 The selected countries

The seven European countries selected in order to administer the interviews are highlighted in Figure 1: Austria, Belgium, Germany, Italy, Poland, Sweden, and United Kingdom. The selection of the seven countries reflected different socio-economic and political patterns of the society.

Figure 1 – European countries of the WP4 pilot survey



3.2 Questionnaire structure and content

The questionnaire structure consists of the following three sections. The first part has been devoted to identify the *respondent's profile*, collecting information regarding the socio-economic status of the

respondent and of her/his family such as age, gender, education level, current employment, marital status, household composition and net family income. Mobility and eating habits are also investigated due to experimental design needs. Socio-economic information are used for both profiling the sample interviewed and detecting possible different tastes in the modelling process.
In the second part of the questionnaire four *unlabelled choice experiments* are presented to the respondents. Before asking people to make a compensatory evaluation among the two alternative options included in each choice task, an introductory section is shown. In particular, the context of environmental and air quality policies is described along with the specific definition of the key terms as well as the policy drivers (in technical term, attributes) characterizing the alternatives. Respondents are asked to compare the two alternatives and select the one evaluated the most acceptable (that provide the highest utility).
In the last section, *attitudinal data* are also included. The consideration of latent factors linked to personal attitudes and motivations (such as environmental perception and awareness, social network, social trust, health awareness) is a plus of the pilot research that allow to better exploit individual heterogeneity. Additional details regarding the questionnaire are available in Avataneo et al. (2014).

Administering the questionnaire in different countries which are characterized by different socio-economic and political profiles has required several adjustments in particular with reference to specific questions (namely, income level and the 'cost of the measure' policy driver) to make them comparable across the seven countries). In particular, *purchasing power parities*[3] were applied to estimate the amount of adjustment needed on the exchange rate between countries, in order to be equivalent to each currency's purchasing power.

3.3 Experimental design, sampling strategy and data gathering

The cooperation between the SEFIRA-WP4 partners from the University of Urbino (UNIURB), the International Institute for Applied System Analysis (IIASA), the King's College of London (KINGS), and the Pragma market research company (PRAGMA) allowed us to narrow the full list of potential drivers (around #30) impacting on the environmental policy acceptability to define the final five policy drivers to include in the choice experiments. They are summarized in Table 1.

The attribute levels are combined into potential policy options and four binary choice sets per interview are constructed. To allow for a rich variation in the combination of attribute levels, a blocking strategy is adopted preparing four versions of the survey form. An unlabelled randomised design, based on the properties of minimal level overlap, level balance and orthogonality, with the blocking option has been estimated with Sawtoohth/CBC software.

After a testing phase, the questionnaire has been administered in seven European countries (Austria, Belgium, Germany, Italy, Poland, Sweden, and United Kingdom) during 2015. With a *computer-assisted web interviewing*[4] (CAWI) technique 2,300 interviews for each country have been collected for a total of around 16,100 interviews.

[3] Source available at: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=prc_ppp_ind&lang=en.
[4] We opted to move from the *computer-assisted telephone interviewing* (CATI) technique to the CAWI one in order to collect a higher number of choice exercises per respondent with a more complex structure in term of policy drivers (attributes) and their levels.

Given the SEFIRA-WP4 research objectives and the policy drivers selected, the target population is defined as people who both use cars/motorcycles for their urban movements and consume meat (beef, pork, lamb, horse) and/or milk or dairy products more than 4 days per month. Since there are no official data available on the distribution of the universe of this target population, data on resident population 18+ in each target country were used as a proxy, to set quotas in terms of age, gender, geographical area crossed by level of urbanisation (the latter variable is based on the new EU classification of NUTS3 into three typologies: 'predominantly rural', 'intermediate' or 'predominantly urban' regions[5]. The questionnaire has been administered by NIPO software which offered the possibility to randomize the positioning of the policy drivers and of the alternatives in the choice experiments (for each block of the design) as well as the positioning of the attitudinal statements inside each own category.

4. Empirical results

4.1. Descriptive statistics

This section provides a summary of the variables used in the econometric analysis. They are here discussed and reported in Annex 0.

Regarding the socio-economic items it emerges as follows. Interviews are equally distributed between female and male (Annex: Table 9) between the countries. Respondents are mainly concentrated in the 25-54 age classes in all countries, even if also the extreme classes (namely, 18-24 years old and > 65 years old[6]) report a number of interviews vary from a 7% for United Kingdom to a 13% of Poland for the 18-24 age class, and from a 7% for Poland to a 24% for Germany and Sweden for the > 65 age class (Annex: Table 10).
With reference to the education level, the majority of respondents for Austria (64%) are concentrated in the Upper secondary school, while for Sweden they are in the Low secondary school (46%); for Belgium and Poland the majority are mainly equally distributed between the Upper secondary school and the Higher Education Part 1 (respectively, 35% and 34%, and 46% and 50%). In Germany respondents are more distributed in all the education levels, but at the same time, with Belgium, they report the highest number of respondents with the maximum level of education (Higher Education Part 2, with a 17%) (Annex: Table 11).
In the German sample there is the highest number of families without children (< 18 years old) (75%), while in the Polish and Italian ones there are the highest numbers of families with children (respectively, 43% and 41%) (Annex: Table 12).
Regarding the marital status, in all the countries the respondent is mainly married (ranging from 58% for Poland to 41% for Austria). However, not marginal percentages are related to 'living together' condition for which Sweden and Austria report the highest values (both 24%) while the lowest has been obtained by Italy and Poland (both 12%) (Annex: Table 13).
With reference to the family size, generally the typical family size across countries consist of two components, except for Italy and Poland in which the family size range from 3 to 4 components (Annex: Table 14).

[5] Source available at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Urban-rural_typology.
[6] Despite the extreme age classes are generally under-collected with the CAWI type of questionnaire administration, the entire interviews are quite properly distributed over age class (with the exception of the Polish sample that presents an underestimated for the 'Over 65' age class).

Table 1 – Characteristics of the experimental design

Types	Descriptions	Country	Levels			
			1	2	3	4
Cost of the measure:	The annual cost you will have to bear as a consequence of the implementation of the environmental policy	Austria:	No cost required	10 euro per year	28 euro per year	55 euro per year
		Belgium:	No cost required	10 euro per year	28 euro per year	55 euro per year
		Germany:	No cost required	10 euro per year	25 euro per year	52 euro per year
		Italy:	No cost required	10 euro per year	25 euro per year	50 euro per year
		Poland:	No cost required	25 zt per year	60 zt per year	120 zt per year
		Sweden:	No cost required	115 sek per year	290 sek per year	580 sek per year
		UK:	No cost required	10 £ per year	23 £ per year	45 £ per year
Required changes in your mobility behaviour *:	The decrease required in the use of polluting means of transportation (car/motorcycle), compared to your present use of these vehicles.	The same for all countries:	No reduction required	-25% of days fewer per month	-50% of days fewer per month	
Required changes in your eating habits *:	The decrease required in the consumption of beef, pork, lamb and horse meat or of milk and dairy products, compared to your present consumption.	The same for all countries:	No reduction required	-25% of days fewer per month	-50% of days fewer per month	
Reduction of premature deaths:	The impact of the policy on the reduction of premature deaths caused by the presence of particulates and ozone. In Europe, there were almost 500,000 premature deaths caused by atmospheric pollution in 2013.	The same for all countries:	50,000 fewer premature deaths per year	125,000 fewer premature deaths per year	250,000 fewer premature deaths per year	
Distribution of measure costs:	It indicates how the costs of the environmental measure must be distributed to the community.	The same for all countries:	Those who pollute more, pay more	The poor pay less		

*Note: * = the two policy drivers about habits have been pivoted based on the stated status quo value stated by each respondent.*

Figure 3 (in Annex) shows the distribution of the stated household's net annual income across countries. Table 15 (in Annex) reports the value of the income classes tested in the questionnaire. It results that the sampled Swedish families are the richest while the Polish ones the poorer. However, for Austria and Belgium there is the highest percentage of missing value (meaning that the respondents refused to answer) (respectively, 22% and 20%).
Table 2 and Table 3 show respectively the individual habits of usually using polluting transport modes (car and motorcycle) and of eating meat and/or milk or dairy products. Regarding the mobility habits (measured as number of days per month), it emerges that across all countries there are specific concentrations at 10, 15, 20, 25 and 30 days per month. However, Italians show an important use of polluting transport modes. The same concentrations in specific days have been found for the eating habits. In this case, British and Swedes have the highest levels of monthly consumption of meat, milk and dairy products.

Table 2 – Habits of using polluting transport modes (car and motorcycle) for journeys within the residential area

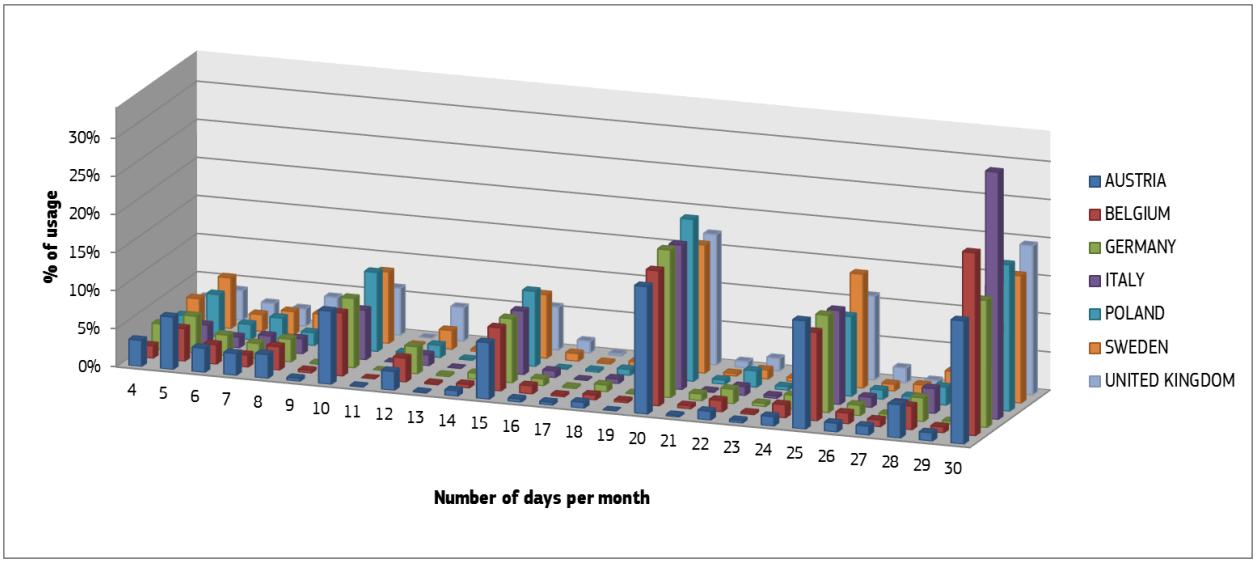


Table 3 – Habits of eating meat and/or milk or dairy products

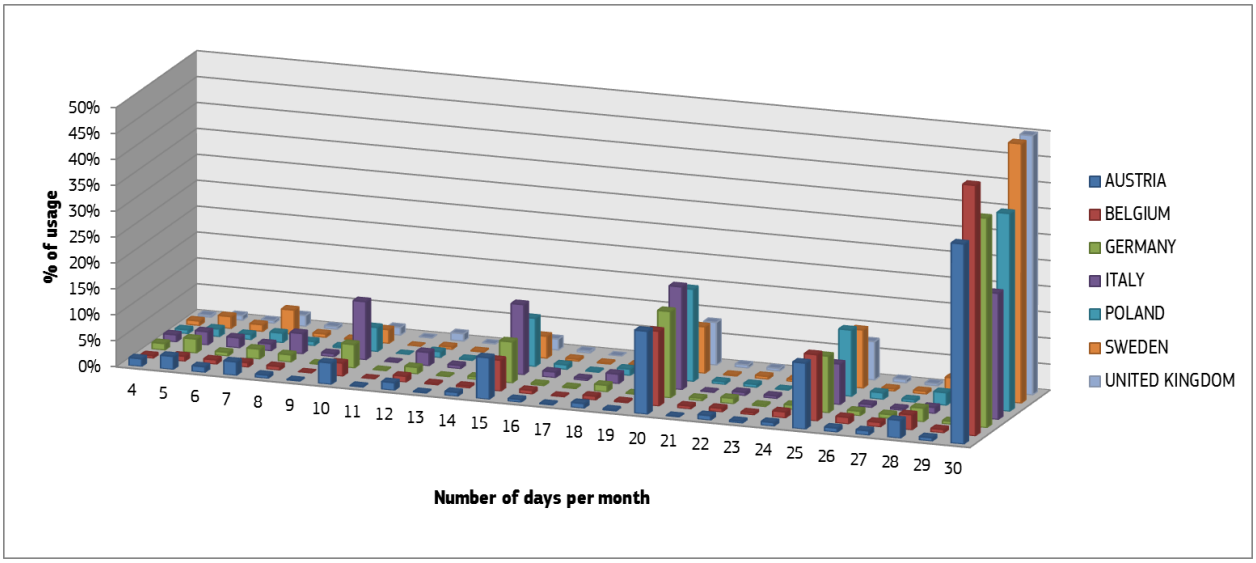


Table 4 reports the respondents' perceptions regarding if, and which, economic sector impacts the most on atmospheric pollution. Overall, it shows that there is a broad consensus for a negative impact of the 'Industry' and the 'Transport' sectors. It is interesting to note that in Poland the 'Domestic waste' has an important share (29%) in negatively impacting on air pollution. Regarding the 'Agriculture' sector more marginal shares are obtained. However, with socio-economic segmentations it is possible to highlight differences in the perceived impact between different socio-economic groups. Two examples are provided below regarding the countries that assigned the highest negative impact to the 'Agriculture' sector – namely, Germany and Belgium. Within the 16% representing the negative impact of the 'Agriculture' sector by the German sample:

- Segmenting by the geographical area ('predominantly rural' (PR), 'intermediate' (IN) or 'predominantly urban' (PU)), the 8% is assigned by respondents living in the PU areas, the 6% is assigned by respondents living in the IN areas, and the remaining 2% refers to respondents living in a PR areas;
- Segmenting by the gender of respondents, the percentage is equally distributed between males and females, showing no effects caused by this variable;
- Segmenting by the age classes of respondents, it seems that an increase in the age of the respondents corresponds to an increase in the perceived sensitivity that the 'Agriculture' sector impact negatively on the air pollution.
- Segmenting by the social status[7] of respondents, the 9% refers to the 'employee and official' group, the 4% to the 'Manager, entrepreneur and professional' group, and the 3% to the 'Skilled worker, shopkeeper, craftsman' group.

Within the 13% representing the negative impact of the 'Agriculture' sector by the Belgian sample:

- Segmenting by the geographical area (IN, PR, PU), the 9% is assigned by respondents living in the PU area, the 3% is assigned by respondents living in the IN area, and the remaining 1% refers to respondents living in a PR area;
- Segmenting by the age classes of respondents, the percentage is equally distributed over the all age classes, showing no effects caused by this variable;
- Segmenting by the gender of respondents, the 8% refers to males and the 5% to females.
- Segmenting by the social status of respondents, the 8% refers to the C1 segment ('employee and official'), the 2% to the AB segment ('Manager, entrepreneur and professional') and to the C2 segment ('Skilled workers, shopkeeper, craftsman'), and the 1% to the DE segment ('Social workers, retirees and the occasional workers').

Regarding the attitudinal statements collected with 5-point Likert scales[8], it emerges as follows. With reference to the statement "*Social networks are important for increasing social involvement in environmental issues*" (Annex: Table 16), generally all countries agree with it. However, the Italian and Polish samples show relevant percentages for the 'I totally agree' level (respectively, 17% and 18%), while the German and Austrian samples are those with the important percentages for the 'I totally disagree' level (respectively, 19% and 14%).

[7] The social status of respondents is coded based on the *head of household occupation* into four classes: AB: 1 = 'AB (Manager, entrepreneur, professional)', 2 = 'C1 (employee, official)' 3 = 'C2 (skilled worker, shopkeeper, craftsman)' 4 = 'DE (social workers, retirees and the occasional workers)'.

[8] The 5-level of the Likert scale were defined as follows: '*I totally disagree*', '*I disagree*', '*Irrelevant*', '*I agree*', '*I totally agree*'.

All countries stated to agree with the statement ''*Environmental protection will provide a better world for me and future generations*'' (Annex: Table 17), while there is less sensitivity toward the item ''*Climate change will influence the life of my children and grandchildren (or that of future generations)*'' (Annex: Table 18).

Table 4 – Perceived impact of economic sectors on atmospheric pollution

Country	Type of impact	Agriculture	Industry	Transportation	Domestic heating	Domestic waste
AUSTRIA	important	10%	82%	62%	8%	9%
	not important	90%	18%	38%	92%	91%
BELGIUM	important	13%	75%	61%	8%	10%
	not important	87%	25%	39%	92%	90%
GERMANY	important	16%	84%	47%	6%	9%
	not important	84%	16%	53%	94%	91%
ITALY	important	6%	79%	66%	15%	14%
	not important	94%	21%	34%	85%	86%
POLAND	important	4%	75%	51%	15%	29%
	not important	96%	25%	49%	85%	71%
SWEDEN	important	13%	68%	67%	3%	6%
	not important	87%	32%	33%	97%	94%
UNITED KINGDOM	important	12%	64%	59%	5%	14%
	not important	89%	36%	41%	95%	86%

Less clustered results have been obtained for the statement ''*I feel under social pressure to adopt an environmentally friendly behaviour*'' (Annex: Table 19), proxy of the social trust sensitivity of respondents, where on average Germans disagree with the above statement (34%), while Italians agree (39%). The statement ''*For me it is important NOT to use open fires and/or wood/pellet stove as an environmentally friendly friendly behaviour*'' (Annex:

Table 21) has been defined in general as 'Irrelevant' as an environmental friendly behaviour.

Regarding behavioural intentions, Italians, British, Belgians, Swedes and Polishes agree at the statement '*Within the next 3 months, I want to undertake an environmentally friendly action*' (Annex: Table 20), while for Germans and Austrians it is 'Irrelevant'.

4.2. Modelling results

The choice data collected were statistically analysed to detect relationships between the levels of the policy drivers (attributes), the socio-demographics characteristics of the respondents and the probability of respondents choosing particular alternatives.

The choice model described in section 2 has been estimated for all the countries.

Table 5 and Table 6 show the results of the seven country-specific binary choice models[9]. The tables report the estimated coefficients of the tested policy drivers (cost of the measure, changes in the mobility and eating habits, reduction of premature deaths, and the '*poor people pay less*' principle for the distribution of the policy cost) with the related z-test. The lower part of the tables report the main statistics related to the model results.

DCMs allow obtaining estimates of the weight of each policy driver. It is important, from an interpretation point of view, to check the statistical significance of the attribute coefficients (z-tests) as well as the consistency of their signs with economic theory.

The *per capita annual cost* of the policy has a correct (negative) sign in all countries; it means that it impacts negatively on the utility so an increase in the measure cost produces a decrease in the utility of the individual. This policy driver is significant in all countries, meaning that it contributes in determining the respondents' choice.

The *mobility habits* and *eating habits* policy drivers being the reduction in the use of polluting means of transport (i.e. car and motorcycle), and in the consumption of beef, pork, lamb or dairy products respectively should have a negative sign; also in this case, an increase in the reduction in the use of polluting mobility modes of transport or in the consumption of the aforementioned eating products causes a decrease in the utility of the respondent. These policy drivers are significant and with the negative signs in all countries except in Italy and in Poland. In fact, in Italy both attributes are with the correct sign but not significant implying that, according to the range of the levels considered in the design, they do not have effects on preferences for potential environmental policies. In Poland the eating habits attribute is significant and with the correct sign, while the mobility habits attribute seems not to be significant.

The *reduction of premature deaths caused by the presence of particulates and ozone* has a correct (positive) sign in all countries; it means that an improvement in the reduction of the premature deaths produce an increase in the utility (so a benefit for the individual). This policy driver is significant in all countries.

The last tested attribute refer to the type of *principle based on which the implementation costs of the policy should be distributed to the community*. The negative sign of the '*poor people pay less*' attribute means that respondents prefer the other principle tested in the survey (the '*polluters pay more*') than the former one. This policy driver is significant in all countries.

As far as the country samples are concerned, among the policy drivers which describe the environmental policy, the annual cost of the policy, the decrease in pollution-related deaths, and the '*polluters pay more*' principle to distribute cost within the community are the drivers with an high impact on the stated policy acceptability in all the countries. As a consequence, the policy acceptability will be especially affected by measures having an impact on these policy drivers at different degrees among the countries.

The policy drivers which present differences across countries are those related to the reduction in mobility and eating habits. In fact, some of these are found for specific countries not significant. The policy drivers, found not significant in the results of the estimated choice models, have the lowest impact on the acceptability of potential environmental policies. Designing policies considering those drivers (i.e. with a low impact on the policy preferences), would contribute to identify potential policies which are more likely to be accepted because they show a low individual's sensitivity towards these policy features. They refer to eating and mobility habits attributes in Italy, while only the latter in Poland. This means that, based on the results obtained, the Italians and Polishes are more inclined than the other nationalities considered, changing their behaviour respectively on mobility and eating habits policy drivers.

[9] The countries are split in two group based on the alphabetic order so to better visualize the tables' content.

Table 5 – Results of the country-specific binary logit models – Group A (Austria, Belgium, Germany)

AUSTRIA			BELGIUM			GERMANY		
Environmental policy drivers:	**Coefficient**	**z**	**Environmental policy drivers:**	**Coefficient**	**z**	**Environmental policy drivers:**	**Coefficient**	**z**
MEASURE COST	-0.01523	-18.87	MEASURE COST	-0.01338	-17.82	MEASURE COST	-0.01738	-21.59
MOBILITY HABITS	-0.0147	-4.28	MOBILITY HABITS	-0.01866	-5.76	MOBILITY HABITS	-0.01569	-4.59
EATINGHABITS	-0.02562	-7.65	EATINGHABITS	-0.01815	-5.67	EATINGHABITS	-0.0126	-3.79
PREMATURE DEATHS	0.00376	17.4	PREMATURE DEATHS	0.00292	13.64	PREMATURE DEATHS	0.00277	12.95
'POOR PAY LESS'' PRINCIPLE	-0.08501	-7.13	'POOR PAY LESS'' PRINCIPLE	-0.08138	-6.97	'POOR PAY LESS'' PRINCIPLE	-0.03222	-2.75
Statistics:			**Statistics:**			**Statistics:**		
Log likelihood function -5971.93057			Log likelihood function -6062.96852			Log likelihood function -5997.07249		
Inf.Cr.AIC = 11953.9 AIC/N = 1.299			Inf.Cr.AIC = 12135.9 AIC/N = 1.319			Inf.Cr.AIC = 12004.1 AIC/N = 1.305		
Number of obs.= 9200, skipped 0 obs			Number of obs.= 9200, skipped 0 obs			Number of obs.= 9200, skipped 0 obs		

Notes: the z-test compares a sample to a defined population and it is typically used for dealing with problems relating to large samples (n > 30): the AIC/N (Akaike information criterion) is a measure of the relative quality of statistical models for a given set of data divided for the sample size.

Table 6 – Results of the country-specific binary logit models – Group B (Italy, Poland, Sweden, United Kingdom)

ITALY			POLAND			SWEDEN			UNITED KINGDOM		
Environmental policy drivers:	**Coefficient**	**z**	**Environmental policy drivers:**	**Coefficient**	**z**	**Environmental policy drivers:**	**Coefficient**	**z**	**Environmental policy drivers:**	**Coefficient**	**z**
MEASURE COST	-0.01188	-13.94	MEASURE COST	-0.00468	-13.94	MEASURE COST	-0.00047	-6.49	MEASURE COST	-0.0213	-22.57
MOBILITY HABITS	-0.00074	-0.24	MOBILITY HABITS	0.00378	1.14	MOBILITY HABITS	-0.04916	-14.13	MOBILITY HABITS	-0.0397	-12
EATINGHABITS	-0.00122	-0.31	EATINGHABITS	-0.00864	-2.59	EATINGHABITS	-0.03815	-12.41	EATINGHABITS	-0.03042	-9.75
PREMATURE DEATHS	0.00492	22.68	PREMATURE DEATHS	0.00164	7.93	PREMATURE DEATHS	0.00108	5.14	PREMATURE DEATHS	0.00315	14.31
'POOR PAY LESS'' PRINCIPLE	-0.0428	-3.56	'POOR PAY LESS'' PRINCIPLE	-0.03404	-2.91	'POOR PAY LESS'' PRINCIPLE	-0.03651	-3.07	'POOR PAY LESS'' PRINCIPLE	-0.05914	-4.96
Statistics:			**Statistics:**			**Statistics:**			**Statistics:**		
Log likelihood function -5774.19266			Log likelihood function -6212.17980			Log likelihood function -6217.39264			Log likelihood function -5968.39872		
Inf.Cr.AIC = 11558.4 AIC/N = 1.256			Inf.Cr.AIC = 12434.4 AIC/N = 1.352			Inf.Cr.AIC = 12444.8 AIC/N = 1.353			Inf.Cr.AIC = 11946.8 AIC/N = 1.299		
Number of obs.= 9204, skipped 0 obs			Number of obs.= 9200, skipped 0 obs			Number of obs.= 9200, skipped 0 obs			Number of obs.= 9200, skipped 0 obs		

Notes: the z-test compares a sample to a defined population and it is typically used for dealing with problems relating to large samples (n > 30): the AIC/N (Akaike information criterion) is a measure of the relative quality of statistical models for a given set of data divided for the sample size.

It is important to highlight that this does not mean that the other policy drivers (those found significant) do not impact on the policy preferences and acceptability; conversely, they have the higher impact on the policy acceptability, so any change of these policy drivers produces important behavioural changes in the policy acceptability. For all the other countries (excluding Italy and Poland), all policy drivers have a high impact on the policy acceptability being all significant. For this individual's sensitivity toward policy drivers' s changes is reported below estimating elasticity measures.

The respondent sensitivity to changes in the tested policy drivers has been analysed estimating direct elasticity measures for each attribute and for each country as detailed in section 2. In choice modelling, the direct elasticity is the percentage change in the probability of choosing a particular alternative in the choice set with respect to a given percentage change in an attribute of the same alternative. In term of policy suggestions, high elasticity values mean a high sensitivity and reaction of respondents for the tested change in the policy driver.
An overview of the results is reported in Table 7. No elasticity measures are estimated for the Italian and Polish samples for the mobility and eating changes because of the not significance of the calibrated coefficients as reported in the previous table.

Table 7 – Summary of the estimated elasticity measures

Policy drivers:	Type of policy change	AUSTRIA	BELGIUM	GERMANY	ITALY	POLAND	SWEDEN	UNITED KINGDOM
Measure COST:	increase	-16%	-15%	-19%	-12%	-11%	-4%	-21%
MOBILITY habits:	reduction	-3%	-4%	-3%	-	-	-10%	-9%
EATING habits:	reduction	-6%	-4%	-3%	-	-2%	-11%	-9%
Premature DEATHS:	reduction	20%	16%	15%	28%	9%	4%	18%
"Poor people pay less" PRINCIPLE:	reduction	-0.34%	-0.31%	-0.06%	-0.11%	-0.07%	-0.05%	-0.18%

An increase of 10% of the '*per capita annual cost*' policy driver implies a subsequent change in the choice probability across countries i.e. a decrease in term of choice probability of 21% for United Kingdom, 19% for Germany, 16% for Austria, 15% for Belgium, 12% for Italy, 11% for Poland, and 4% for Sweden. Across the countries, British and Germans seem more sensitive to changes in this policy driver, while Swedish seem the less sensitive.
A 10% increase of the monthly reduction required in the use of polluting modes of transport mainly impacts the Swedes with the highest negative reaction (-10%) followed by British (-9%). Similar results are obtained for the 10% increase in the reduction of eating habits of the respondents. Swedes and British are the most sensitive for changes in this policy driver, while Polishes show the lowest change in the choice probability with a 2%.
A 10% improvement in the reduction of the premature deaths produces an increase in the choice probability of 28% for Italians and 20% for Austrians, whereas Swedes report the lowest change in the choice probability with a 4%.
Austrians and Italians seem to be the more sensitive to the reduction of premature deaths caused by atmospheric pollution. On the contrary, it can be noted that those countries with a low elasticity value (as in the case of Sweden) does not necessarily mean a low 'sensibility' to the problem, but could be explained by the fact that for instance the considered country has already internalised the importance of the specific policy driver. In any case the interpretation of such results is matter of discussion.

Having a policy where costs are distributed according to the principle of '*poor people pay less*' produces a decrease in choice probability of 0.34% in Austria and a 0.32 in Belgium.

4.3. Analysis of the policy acceptability packages

This section focuses in defining the individual acceptability of the tested policy packages via WTP measures and in simulating the *ex-ante* impact of a potential policy.

The estimated average WTP measures for each country have been used to classify the tested potential policies by the level of acceptability. Three different groups are qualitatively defined on the basis of the results derived by the following question: '*Can you please indicate which measure you would find acceptable*?'. For the various policy packages investigated, we calculated the percentage of respondents who considered them acceptable and, linking this information to the estimated WTP, we differentiated by colours (see Figure 2). The red colour corresponds to a low level of policy acceptability, while the green colour represents the higher level of policy acceptability.

Figure 2 shows the positioning in term of quantified policy acceptability of two policies in three different groups of acceptability levels (e.g. low, medium, high). In particular, in left-hand side the policy n. 3 (i.e. tested in the choice experiments) has been presented, while the right-hand side reports the simulation results of a new potential policy.

The description of the two policy measures in term of policy drivers' levels is provided in Table 8.

Policy 1 corresponds to the measure n. 3 tested in the choice experiments, while *Policy 2* is a new potential policy *ad hoc* simulated. The former policy implies important behavioural changes in the mobility and eating habits of respondents. The latter is a cost-based policy (50 €/year measure cost) without requiring behavioural changes (i.e. no reduction in the mobility and eating policy drivers), *ceteris paribus*.

Table 8 – Characteristics of the considered policy packages

Policy drivers	Policy 1	Policy 2
	Tested attributes-levels	*Tested attributes-levels*
Measure COST:	No cost required	50 €/year
MOBILITY changes:	-50% of days fewer per month	No reduction required
EATING changes:	-50% of days fewer per month	No reduction required
Premature DEATHS:	100,000 premature deaths	100,000 premature deaths
'*Poor people pay less*' PRINCIPLE:	adoption	Adoption

Overall, it is interesting to note that both policies report different levels of acceptability between countries. In addition, also inside a specific acceptability band, for instance the low acceptability one (coloured in red), different degrees of the calculated acceptability emerged.

Regarding the *Policy 1*, it seems to be more accepted in those countries where 'mobility habits' and 'eating habits' policy drivers are not significant (Italy and Poland) – as found in the choice model results. The cost-based simulated policy (*Policy 2*) seems to modify the acceptability level across countries increasing in those countries with a high average family income such as Sweden and United Kingdom, penalising the acceptability level for all the other countries.

The present exercise is an example of how DCMs might be used in simulating the *ex-ante* impact of policies tested in the survey design and comparing them among various countries based on different degrees of policy acceptability.

Figure 2 – Defining policy acceptability for potential environmental policy

5. Conclusions

The use of behavioural modelling and related techniques to evaluate environmental and air quality policies is timely. Policies based on technical measures and technological solutions have been successfully used for many decades, but there is increasing evidence that such measures will not be enough to reduce air pollution concentrations to acceptable levels.

Policies involving non-technical measures are therefore likely to play an increasingly important role in the future air quality management in Europe. Such policies will inevitably involve behavioural changes, purchasing decisions, and lifestyle changes. Ex-ante assessing the impacts of these policies and in particular their acceptability and acceptance will require systematic study and the use of proven techniques.

The literature on choice modelling suggests that this methodology can be used to analyse individual preferences toward potential policies.

The SEFIRA-WP4 pilot study designed and implemented in seven European countries a choice experiment survey to analyse public preferences for potential environmental and air quality policies aiming at: *i)* identifying individuals' preferences for selected environmental policy drivers, and *ii)* highlighting individuals' heterogeneity in eliciting preferences and acceptance for environmental policy.

Among the tested policy drivers in describing the environmental policy, the annual cost of the policy, the decrease in pollution-related deaths, and the '*polluters pay more*' principle to distribute cost within the community are the drivers with a high impact on the stated policy acceptability in all the countries. As a consequence, the policy acceptability will be especially affected by measures having an impact on these policy drivers. The policy drivers which present differences across countries are those related to the reduction in mobility and eating habits. In fact, some of these have been found to be not significant for specific countries. Designing policies considering policy drivers with a low impact on policy acceptability would contribute to identify potential policies which are more likely to be accepted. This is the case for

Italy and Poland where people are more inclined to change their behaviour on the eating and mobility habits (the latter only for Poland). It is important to highlight that this does not mean that the other policy drivers (those found significant) do not impact on the policy acceptability; conversely, they have the higher impact on the policy acceptability, so any change of these policy drivers produces important behavioural changes in the policy acceptability. For all the other countries (excluding Italy and Poland), all policy drivers have a high impact on the policy acceptability being all significant.
The estimated importance via elasticity measures allowed to further explore, for each country, the individuals' sensitivity to policy drivers. Across the countries, British and Germans seem more sensitive to changes in the '*per capita annual cost*' policy driver, while Swedish seem less sensitive. Swedish and British are more sensitive to changes in the behavioural policy drivers (i.e. mobility and eating habits). Italians and Austrians are more sensitive to changes in the premature deaths policy driver, and Belgians and Austrian are the most sensitive to changes if the policy costs are distributed according to the principle of '*poor people pay less*'.

Using country-specific WTP measures, the tested potential policies have been classified by the level of acceptability (low, medium and high). An example was provided and compared with a new potential policy simulated with the models' results. Based on the modelling results, further analysis also suggest, the *Policy 1* (behavioural-based policy) was most accepted in those countries where '*mobility habits*' and '*eating habits*' policy drivers are not significant (Italy and Poland); while the *Policy 2* (cost-based simulated policy) seems to penalising the acceptability level for all the other countries with a low family income level (except Sweden and United Kingdom).

Annex

Details of descriptive statistics

Table 9 – Distribution of respondents by Gender

Countries:	Male	Female	Total:
AUSTRIA	48%	52%	100%
BELGIUM	49%	51%	100%
GERMANY	49%	51%	100%
ITALY	48%	52%	100%
POLAND	46%	54%	100%
SWEDEN	50%	50%	100%
UNITED KINGDOM	51%	49%	100%

Table 10 – Distribution of respondents by Age class

Countries:	18-24 years	25-34 years	35-44 years	45-54 years	55-64 years	>65 years	Total:
AUSTRIA	11%	22%	19%	22%	16%	10%	100%
BELGIUM	11%	17%	18%	20%	17%	17%	100%
GERMANY	9%	15%	16%	20%	16%	24%	100%
ITALY	10%	18%	23%	21%	16%	12%	100%
POLAND	13%	22%	22%	18%	18%	7%	100%
SWEDEN	10%	15%	17%	18%	16%	24%	100%
UNITED KINGDOM	7%	17%	18%	20%	16%	22%	100%

Table 11 – Distribution of respondents by Education level

Countries:	Primary School	Lower Secondary School	Upper Secondary School	Higher Education Part 1	Higher Education Part 2	Total:
AUSTRIA	1%	12%	64%	11%	13%	100%
BELGIUM	3%	11%	35%	34%	17%	100%
GERMANY	10%	30%	32%	11%	17%	100%
ITALY	1%	10%	56%	26%	8%	100%
POLAND	0%	1%	46%	50%	3%	100%
SWEDEN	4%	46%	33%	11%	6%	100%
UNITED KINGDOM	0%	22%	38%	26%	14%	100%
Notes: Higher Education - Part 1 = Graduate; Higher Education - Part 1 = Postgraduate (Masters, Ph.D.)						

Table 12 – Distribution of respondents by Number of children (< 18 year old) in the family

Countries:	no children	1	2	3	4	5	6	7	8	Total:
AUSTRIA	72%	16%	10%	2%	1%	1%	-	-	-	100%
BELGIUM	69%	14%	10%	3%	1%	1%	1%	1%	-	100%
GERMANY	75%	14%	8%	1%	1%	1%	-	-	-	100%
ITALY	52%	21%	14%	3%	1%	1%	1%	-	-	100%
POLAND	57%	25%	14%	2%	1%	1%	-	-	-	100%
SWEDEN	70%	13%	11%	3%	1%	1%	0%	1%	1%	100%
UNITED KINGDOM	68%	14%	13%	2%	1%	0%	1%	1%	-	100%

Table 13 – Distribution of respondents by Marital status

Countries:	Single	Married	Living together	Widow/er	Divorced	Separated	Refuses to answer	Total:
AUSTRIA	22%	41%	24%	1%	8%	1%	2%	100%
BELGIUM	23%	46%	17%	2%	9%	1%	1%	100%
GERMANY	20%	50%	16%	3%	9%	1%	1%	100%
ITALY	26%	55%	12%	2%	2%	3%	0%	100%
POLAND	20%	58%	12%	3%	5%	1%	1%	100%
SWEDEN	19%	43%	24%	3%	7%	2%	3%	100%
UNITED KINGDOM	20%	54%	14%	3%	7%	1%	0%	100%

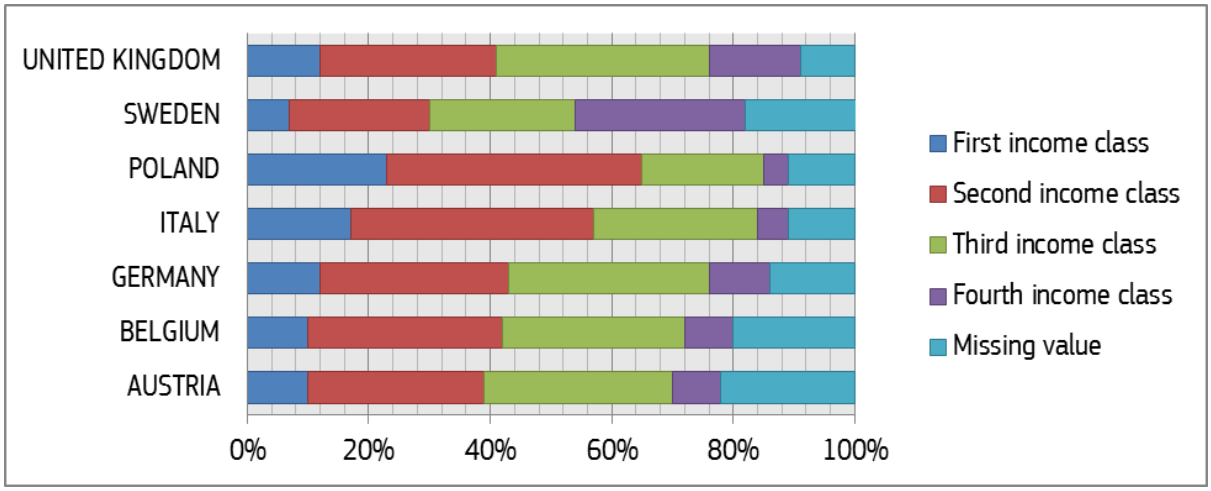
Table 14 – Distribution of respondents by Family size (included the respondent)

Countries:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total:
AUSTRIA	18%	41%	19%	13%	4%	1%	1%	1%	1%	1%	-	-	-	-	-	100%
BELGIUM	14%	40%	19%	16%	6%	2%	1%	1%	1%	-	-	-	-	-	-	100%
GERMANY	19%	45%	17%	11%	3%	1%	1%	1%	-	-	1%	-	-	-	1%	100%
ITALY	5%	24%	28%	30%	7%	1%	1%	1%	1%	-	1%	1%	-	-	-	100%
POLAND	6%	27%	30%	22%	8%	3%	1%	1%	1%	1%	-	-	-	-	-	100%
SWEDEN	20%	43%	14%	13%	5%	1%	1%	1%	-	1%	1%	-	-	-	-	100%
UNITED KINGDOM	16%	37%	18%	18%	6%	2%	1%	1%	-	-	-	1%	-	-	-	100%

Table 15 – Distribution of respondents by Household's net annual income (Table)

Countries:	First income class	Second income class	Third income class	Fourth income class	Missing value	Total:
AUSTRIA	*"Bis zu 15,000 Euro"*	*"15,001 - 30,000 Euro"*	*"30,001 - 60,000 Euro"*	*"Uber 60,000 Euro"*	*"Refuse to answer"*	100%
	10%	29%	31%	8%	22%	
BELGIUM	*'Jusqu' 15,000 Euro"*	*"15,001 - 30,000 Euro"*	*"30,001 - 60,000 Euro"*	*"Plus de 60,000 Euro"*	*"Refuse to answer"*	100%
	10%	32%	30%	8%	20%	
GERMANY	*'Bis zu 15,000 Euro"*	*"15,001 - 30,000 Euro"*	*"30,001 - 60,000 Euro"*	*'Uber 60,000 Euro"*	*"Refuse to answer"*	100%
	12%	31%	33%	10%	14%	
ITALY	*"Fino a 15,000 Euro"*	*"15,001 - 30,000 Euro"*	*"30,001 - 60,000 Euro"*	*"Oltre 60,000 Euro*	*"Refuse to answer"*	100%
	17%	40%	27%	5%	11%	
POLAND	*"Ponizej 36,000 zl"*	*"36,001 - 72,000 zl"*	*"72,001 - 145,000 zl - "*	*"Powyzej 145,001 zl - "*	*"Refuse to answer"*	100%
	23%	42%	20%	4%	11%	
SWEDEN	*"Upp till 175,000 SEK"*	*"175,000 - 350,000 SEK"*	*"350,001 - 700,000 SEK"*	*"Over 700,000 SEK"*	*"Refuse to answer"*	100%
	7%	23%	24%	28%	18%	
UNITED KINGDOM	*"Up to 14,000 £"*	*"14,001 - 28,000 £"*	*"28,001 - 55,000 £"*	*"Over 55,000 £"*	*"Refuse to answer"*	100%
	12%	29%	35%	15%	9%	

Figure 3 – Distribution of respondents by Household's net annual income (Figure)



Notes: First income class = Up to 15,000 Euro; Second income class = Between 15,001 – 30,000 Euro; Third income class = Between 30,001 – 60,000 Euro; Fourth income class = Over 60,000 Euro; Missing value = Refuse to answer.

Table 16 – (Dis)agreement with the attitudinal item of the Social Networks

Item: "Social networks are important for increasing social involvement in environmental issues."

Countries:	'I totally disagree"	'I disagree"	'Irrelevant"	'I agree"	'I totally agree"	Total:
AUSTRIA	14%	15%	27%	36%	8%	100%
BELGIUM	9%	12%	28%	42%	10%	100%
GERMANY	19%	19%	26%	30%	6%	100%
ITALY	4%	7%	24%	48%	17%	100%
POLAND	3%	6%	21%	52%	18%	100%
SWEDEN	9%	9%	26%	42%	14%	100%
UNITED KINGDOM	11%	13%	25%	39%	12%	100%

Table 17 – (Dis)agreement with the attitudinal item of the Environmental sensitivity

Item: "Environmental protection will provide a better world for me and future generations."

Countries:	'I totally disagree"	'I disagree"	'Irrelevant"	'I agree"	'I totally agree"	Total:
AUSTRIA	2%	1%	5%	39%	53%	100%
BELGIUM	2%	2%	10%	48%	38%	100%
GERMANY	1%	2%	7%	45%	45%	100%
ITALY	2%	1%	5%	35%	56%	100%
POLAND	1%	2%	12%	49%	36%	100%
SWEDEN	2%	3%	8%	41%	46%	100%
UNITED KINGDOM	2%	5%	11%	51%	32%	100%

Table 18 - (Dis)agreement with the attitudinal item of the Climate Change sensitivity

Item: "Climate change will influence the life of my children and grandchildren (or that of future generations)."

Countries:	'I totally disagree"	'I disagree"	'Irrelevant"	'I agree"	'I totally agree"	Total:
AUSTRIA	2%	4%	8%	43%	42%	100%
BELGIUM	2%	4%	12%	50%	33%	100%
GERMANY	2%	4%	11%	45%	39%	100%
ITALY	1%	2%	8%	46%	42%	100%
POLAND	2%	4%	13%	53%	28%	100%
SWEDEN	3%	4%	10%	41%	43%	100%
UNITED KINGDOM	4%	6%	14%	45%	31%	100%

Table 19 – (Dis)agreement with the attitudinal item of the Social Trust sensitivity

Item: "I feel under social pressure to adopt an environmentally friendly behaviour."

Countries:	'I totally disagree"	'I disagree"	'Irrelevant"	'I agree"	'I totally agree"	Total:
AUSTRIA	19%	32%	31%	14%	3%	100%
BELGIUM	7%	24%	31%	32%	6%	100%
GERMANY	18%	34%	28%	17%	4%	100%
ITALY	6%	15%	29%	39%	12%	100%
POLAND	8%	25%	29%	32%	6%	100%
SWEDEN	11%	20%	32%	30%	8%	100%
UNITED KINGDOM	10%	31%	21%	31%	7%	100%

Table 20 – (Dis)agreement with the attitudinal item of the Behavioural Intention

Item: "Within the next 3 months, I want to undertake an environmentally friendly action"

Countries:	'I totally disagree"	'I disagree"	'Irrelevant"	'I agree"	'I totally agree"	Total:
AUSTRIA	5%	9%	40%	36%	9%	100%
BELGIUM	4%	9%	31%	46%	10%	100%
GERMANY	5%	9%	40%	36%	9%	100%
ITALY	1%	2%	17%	54%	26%	100%
POLAND	3%	5%	31%	50%	11%	100%
SWEDEN	8%	14%	32%	37%	10%	100%
UNITED KINGDOM	6%	11%	30%	40%	13%	100%

Table 21 – (Dis)agreement with the attitudinal item of the Environmentally Friendly Behaviour: *open fires and/or wood/pellet stoves*

Item: "For me it is important NOT to use open fires and/or wood/pellet stove as an environmentally friendly behaviour"

Countries:	'I totally disagree"	'I disagree"	'Irrelevant"	'I agree"	'I totally agree"	Total:
AUSTRIA	7%	13%	30%	32%	19%	100%
BELGIUM	11%	21%	36%	24%	8%	100%
GERMANY	4%	9%	26%	36%	25%	100%
ITALY	9%	20%	39%	23%	8%	100%
POLAND	6%	14%	33%	36%	12%	100%
SWEDEN	18%	23%	38%	15%	5%	100%
UNITED KINGDOM	9%	20%	36%	25%	9%	100%

Table 22 – (Dis)agreement with the attitudinal item of the Environmentally Friendly Behaviour: low emission cars

Item: "For me it is important to buy a low emission car as an environmentally friendly behaviour"

Countries:	'I totally disagree"	'I disagree"	'Irrelevant"	'I agree"	'I totally agree"	Total:
AUSTRIA	4%	6%	17%	52%	21%	100%
BELGIUM	2%	5%	16%	56%	21%	100%
GERMANY	3%	6%	18%	53%	20%	100%
ITALY	2%	3%	11%	50%	34%	100%
POLAND	3%	5%	22%	51%	19%	100%
SWEDEN	3%	5%	15%	46%	30%	100%
UNITED KINGDOM	4%	10%	21%	48%	18%	100%

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